ASD/TDC Mezzanine Test Procedures

Initial procedure

Receiving

The shipping boxes should be taken to the ground floor laboratory. The boards should be kept inside the shipping box until the testing procedure can start.

Check−in and label

Boards should be unpacked on the ground floor laboratory. Create one summary sheet for each board. Enter manufacture name [1], the card type [2], the revision label[3] and card number. The number should be composed of the revision label, a dash and 3 digits, e.g. **J−032** or **1.1−045**. This number should also be marked on the card using a red permanent marker. Enter the date the shipment was received and the name of the person that received it.

Visual inspection

This is a quick general inspection to make sure that all the components are present and that the cards didn't suffer any major damage during shipment. The following should be checked:

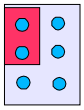
1. No components missing
2. No shorts in protection circuit
3. 36−pin connector in correct position /_____\
4. Pins of headers not bent

Jumpers

The boards could be shipped from the manufacturer with some jumpers that need to be removed. Also, it is possible that a couple of jumpers need to be added to the 3x8 rev. J card. In all cards, the threshold circuit jumper needs to be added.

Check and if needed modify the following in the 3x8 rev. J card:

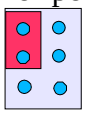
1. Remove jumpers JP16, JP18 (DGNG and AGND) and JP20 (AMT reset)
2. Add jumpers SP6 and SP9 (DGNG and shield connection)
3. Put a jumper in the 100mil header (JP1). The jumper should be ready for pot operation, *i.e.* connecting pins 1 and 3 of the header.



1 Currently EMA
2 3x8 or 4x6
3 Currently rev. J for 3x8 cards and rev. 1.1 for 4x6 cards

Modify the following in the 4x6 rev. 1.1 card:

1. Remove jumper that make the digital−analog ground connection.
2. Put a jumper in the 100mil header (JP7). The jumper should be ready for pot operation, *i.e.* connecting pins 1 and 3 of the header.



CPLD programming

Use power supply with 5V output and 36−pin power connector. The initial current draw should be around 0.35 A. Record digital current after programming the CPLD.

The current .jed file to use is located in the //heplpc7/public/v2 folder. This file might be updated later.

Electrical tests

The electrical tests are performed automatically using a custom made test board. There are several tests which are all controlled by computer, however some human intervention is needed during the testing process.

In these instructions, we will start with a description of the testing setup. This will be helpful in case there is the need for some modification or some problems develop with the setup. The second part of these instructions are a description of all the tests that should be done. This is done in the same order as the tests are suppose to proceed.

Testing setup

The hardware involved in this test setup is the following:

1 Computer running the MiniDAQ software with the modifications for these tests (MezzTest)

1 CSM−0 on a VME crate

2 Pulse generators (HP8116A and HP8082A)

1 Scanning multimeter (Keithley 2700)

1 Custom made Test board that takes a mezzanine card

1 Adapter board connecting the CSM to Mezzanine card through the test board

3 Low voltage power suppies

HP6303B − 3.3V for adapter board

Kepco PS MSK 10−10M − 5.5V for mezzanine card analog power

Kepco PS MPS 620M − 5.5V for mezzanine card digital power

1 Model A101 attenuator

Cabling

The cables between the CSM and the adapter board are cat.5 network cables. The data cables are shielded. The data cable being used for the test is labeled 3 and it is connected to slot 5 of the CSM. The JTAG cables are not shielded.

The adapter board is connected to the test card with a printer cable (labeled A).

In the test card, there is a second printer cable (labeled C) that connects to the mezzanine card.

A large 25−pair flat cable connects the test card to the scanning multimeter. This is used for voltage and current monitoring. A smaller 8−twisted pair flat cable is used as a "spy" cable to monitor the TDC LVDS levels during one of the tests. A thin grey flat cable is used to monitor the ASD LVDS levels during another test. The threshold voltage of the mezzanine card is monitored using a blue and black small twisted pair cable.

The pulse injection is done through a LEMO cable directly into the test board. The HP8116A pulse generator is connected to the HP8082A pulse generator and the CSM trigger input with 2 BNC cables. The HP8082A output goes through a BNC cable into a Model A101 Attenuator. From there, a LEMO cable carries the pulse into the test board.

Each low voltage power supply is independently connected to the adapter board by single red−black twisted pair cables. In all the power cables, the ground (black wire) is on the left side (outer most side) of the power connectors on the adapter board.

Electrical test procedure

The procedure for testing 3x8 and 4x6 ASD Mezzanine cards is very similar. Here, we will provide instruction for both cards at the same time and emphasize the differences when necessary.

Starting a batch of tests

Prior to start testing you will need to make sure that all the equipment correctly connected and power up. These includes all power supplies, pulse generators, multimeter, VME crate and computer. If the computer and/or the VME crate were powered down at any time prior to the tests there is some extra necessary steps.

To be able to use the MiniDaq software you have to login the computer with username MiniDaq and the usual password. Each time the computer and/or the VME crate are powered down you need to run RESMAN. To do this press the START button. You will find RESMAN in: START −> Ni−vxi −> Resman. It should take about 5 seconds scanning and it finishes with a successful message. Just press CLOSE and you are ready to run the data acquisition software.

In the computer desktop there are a few shortcuts that are relevant for our tests:

- Shortcut to cvi : This opens LabWindows/CVI. Use it if you want to check or modify

the test code.

- Shortcut to MezzTest: This is the folder with all the test software and data.
- MezzTest: This is the test application. In principle, you will only need this one.
- Shortcut to MezzTests.log: Log file in text format with information about all the tests done so far. This shouldn't be edited unless you know what you are doing!
- Shortcut to Resman

To start the test software use the MezzTest shortcut. This will open a MiniDaq window with an extra button called "MezzTest". Pressing this button opens the Mezz Test Stand window which contains a list of all the tests to be performed. The tests of a batch of boards are all run from this window.

Testing each board

Making the connections

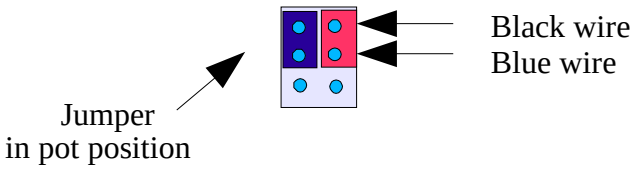
The test board was designed to be used with both 3x8 and 4x6 mezzanine cards however the placement of the mezzanine card on the test−card is different for each of the card types. There are some marks on the test stand PCB board that help you to do this.

The 3x8 card should be placed on the first three connectors. Each of the 3x8 mezzanine card input connectors should be flush to the top of the test−card connectors. That is, there should be one extra pair of unconnected pins on the lower side of the test−card (the one with the hole grid).

The 4x6 card has 4 input connectors and they should be placed flush with lower side of the test−card connectors. That is, there should be an extra pair of unconnected pins on the top side of the test−card.

Connect the printer cable from the test−board (left connector) to the mezzanine card under test. This cable is currently labeled C. Finally, connect the threshold voltage monitoring cable (blue−black twisted pair) to the Mezzanine card threshold connector:

3x8 Mezzanine card: JP1 connector
4x6 Mezzanine card: J7 connector



Turn on the analog and digital power supplies. The current should be about 0.35 A on each power supply.

Running the tests

All the test are run from the Mezzanine Test Stand window. In this window, you can select which tests to be done. This can be done by pressing the box next to each test name and/or by pressing the "Select All" and "Select None" buttons. For now, we want to run all the tests on one given card, so press "Select All".

To start one run of tests press "Go". This opens a window labeled "Log Header". Please enter your initials here, the card type (3x8 or 4x6 − this is a selectable menu), the card revision and the card number.

The program will not proceed if you do not enter your initials (sorry!). The current card revisions are "J" for the 3x8 mezzanine cards and "1.1" for the 4x6 cards. The code does not know about these so you need to enter them manually. No error checking is done. The card number is the one written on card's white label (do not include the revision number). Press "OK" when done and the testing will start. The values you have entered will be saved for the next card.

The tests run in the order indicated on the "Mezzanine Test Stand" window. Most of them are automatic and do not need any user intervention. The ones that do need some human help will prompt the user for some specific action. Most of the messages should be hopefully clear enough. Nevertheless some extra information is given below.

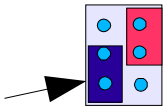
All tests start with a red LED next to them indicating that they were not yet done. After each test is completed the LED turns green if the test was successful, or remains red if it failed. Messages with status information and with the test results are written to the "Standard Input/Output" window.

1. Power test

   This is the first test. It measures the voltages before and after the power regulators in the mezzanine card. It also measures the digital and analog currents provided to the cards. The test runs automatically and it will produce a fatal error if any of the quantities measured are outside reasonable ranges. If the test fails check the output in the "Standard Input/Output" window. This will indicate the cause of the problem. Common problems are power supplies off or without enough input voltage.

2. Threshold Pot

   This tests the threshold circuit as operated manually by the potentiometer. It measures the maximum and minimum threshold voltages and compares that to expectations. When asked, move the threshold jumper to the "pot" position (as indicated above) and press the "local" button in the Keithley multimeter. This gives you access to the reading of the threshold voltage being made by the multimeter. Using a small screw driver turn the potentiometer *clockwise* and read the measurement in the multimeter. Stop turning the potentiometer when the voltage stabilizes, and press OK in the pop−up window. The computer will read the voltage value at this time and ask you to move the potentiometer in the opposite direction (*counter−clockwise*). Repeat the same operation and move the jumper to the DAC position (as shown below) when prompted. The threshold voltage should be maximum when the potentiometer is fully turned clockwise and minimum when fully turned counter−clockwise.



Jumper
in DAC position

3. Read ID code

   Reads the AMT ID code. This will fail with a fatal error if there are some problems with the AMT chip or the JTAG loop. This test runs automatically.

4. Check JTAG programming

   Sends several streams of bits and checks for their return. This tests the JTAG path and it runs automatically. If the check is not OK it will result in a fatal error.

5. DAC linearity

   Tests if the threshold circuit using the DAC is working properly. It checks if the maximum and minimum threshold voltages are correct and if voltage is linear with the DAC digital input. The test runs automatically.

6. ASD LVDS levels

   This test measures the LVDS levels at the ASD discriminator outputs. Depending on which mezzanine card being tested there are 3 or 4 small headers on the card that need to be read. These have 16 pins each and are located in the center of the mezzanine card. The program will start by asking you to put the "LVDS cable on the first set of outputs". The "LVDS cable" is the thin grey cable. The "first set of outputs" is the uppermost header, i.e. the closest to the 36−pin connector. Pin 1 in the grey cable (indicated by the red line) should be connected to the pin closest to the 36−pin connector. The connector on the cable has more than 16 sockets so one has to be careful matching the first 16 sockets to the 16 pins on the header. Failure to do so will result on failing the test.

   After plugging−in the cable, press OK. The voltages will be measured for this set of outputs. Then move the cable to the closest connector down the card and press OK again. Repeat the procedure until all the 3 or 4 connectors have been readout. The computer knows which card is being tested and therefore it knows how many measurements to make.

   After all measurements are done, remove the cable. Otherwise, the next tests will fail.

   WARNING: the pins on the mezzanine card headers are very fragile so please be careful when plugging in the cable

   The expected measurements are around 180 mV. The current tolerance is 25 mV.

7. TDC LVDS levels

   This measures the LVDS levels to/from the TDC. The measurement is done by "spying" on the 36−pin connector using the large header between the 2 connectors on the test board.

   Place the 8−twisted pair flat cable ("spy" cable) at the end of the large header. Pin 1 of the cable is the brown conductor and it should be placed on the pin labeled +TMS. This will allows us to measure the LVDS levels of the JTAG pairs (TMS, TCK, TDI, TDO) and the TDC data pairs (STB, DAT and ENC). The TDC CLK will not be read out. Press OK to start the measurement.

Remove the "spy" cable otherwise the following tests will fail.

This LVDS levels are expected to be around 320 mV with a tolerance of 100 mV. The strobe LVDS levels is allowed to be between −420 mV and + 420 mV.

8. Check Headers/Trailers

   This checks the basic operation of the AMT−1. A software trigger is sent to the chip and we check if we get any response from it. If so, the card passes. This is an automatic test.

9. Noise Rate

   This is a measurement of the noise rate at the card. Our test card does not provide the correct termination for the ASD chip therefore we have to make this test with a threshold different from the nominal value. The threshold voltage used is around 37 mV which should correspond to 60 mV when the card is on the chamber. The card is consecutively pulsed with software triggers and we measure the number of hits in a trigger window. The measurement is done with a precision of about 2 Hz. To reach this precision the test will take a several seconds to run.

   The limit is currently set to 1kHz but we expect the noise rate to be considerably smaller most of the time.

10. Single Pulse Injection

    In this test we inject 2 consecutive pulses into the ASD chip and trigger the CSM−0 when sending the first pulse. This is accomplished with the two pulse generators being used. Each pulse width is 19 ns. The time delay between each leading pulse edge is 400 ns. This is the time we want to measure with this test. The pulse amplitude from the pulse generator is 600mV which goes through an attenuator set for 0.5. On each of these pulse tests we pulse even and odd channels independently.

    Start by moving the pulse injection jumper (located next to the LEMO connector input) to the "even" position, i.e. the uppermost position. Press OK for making the measurement. Then move the jumper to the "odd" position and press OK again.

    We expect to have 2 words on each channel that was pulsed and no words on the channels that were not pulsed. The width of pulse should be close 400 ns.

    There might be some need to calibrate the input pulse width using the scope. For that, connect the HP8082A output directly into the scope and get it running in "norm" mode. Change the scope settings so that you can see the 2 pulses simultaneously on the screen. Meaure the time characteristics of the wave which should give you the period. This is the measurement one wants to make with the AMT−1. To change these move the "Vernier" knob corresponding to the "pulse delay" in the HP8082A. It would be nice if this time would be kept within 1ns of 400 ns during all the tests.

11. Low rate pulse injection

    This test is similar to the above one but the AMT−1 is pulsed at a higher rate, 500 Hz. Move the jumper as indicated above.

12. High rate pulse injection

Same test but even at a higher rate. Now the AMT−1 is pulsed at 40 kHz. Move the jumper according the indications.

After all tests are done, the "Log Trailer" window will pop−up. Please indicate if you want the test results to be saved into the log file (check the corresponding box) and enter any necessary comments to be added to the log file. The comments shouldn't include commas because they are used to separate the fields in the log file. Hyphens and underscores are OK.

If something went wrong during testing and several of the tests failed it will be better not to save the information into the log file and just repeat the tests. Of course, if the board actually failed then a log entry should be made.

Independent of the electronic log file, each mezzanine card should be accompanied by a summary sheet with all the information relative to the specific card. Please enter the results of the electrical tests into this sheet. Include the date and your initials as well as any relevant extra information.

Turn off the analog and digital power supplies before removing the mezzanine card from the test stand.

Final Checkout and shipping

An ASD mezzanine card is ready to ship if it passes all the electrical tests above and does not have any other problems. All the information should be in the summary sheet. The cards should be placed inside the anti−static bags that came from the assembly house and packed with bubble wrap inside boxes. Please record the date the cards were packed and shipped. Also, record the number of cards shipped and who is receiving them.

Some common failure modes

1. Passes all tests up to noise rate test but fails noise rate test.
    1. Noise rate for all channels very similar with just a few exceptions. Typically noise rate around 70 kHz.
    2. In the pulse injection test, no pulses are detected on any channel

       POSSIBLE CAUSE: Card wrongly placed on test stand. Move 4x6 card one pin up or 3x8 card one pin down.